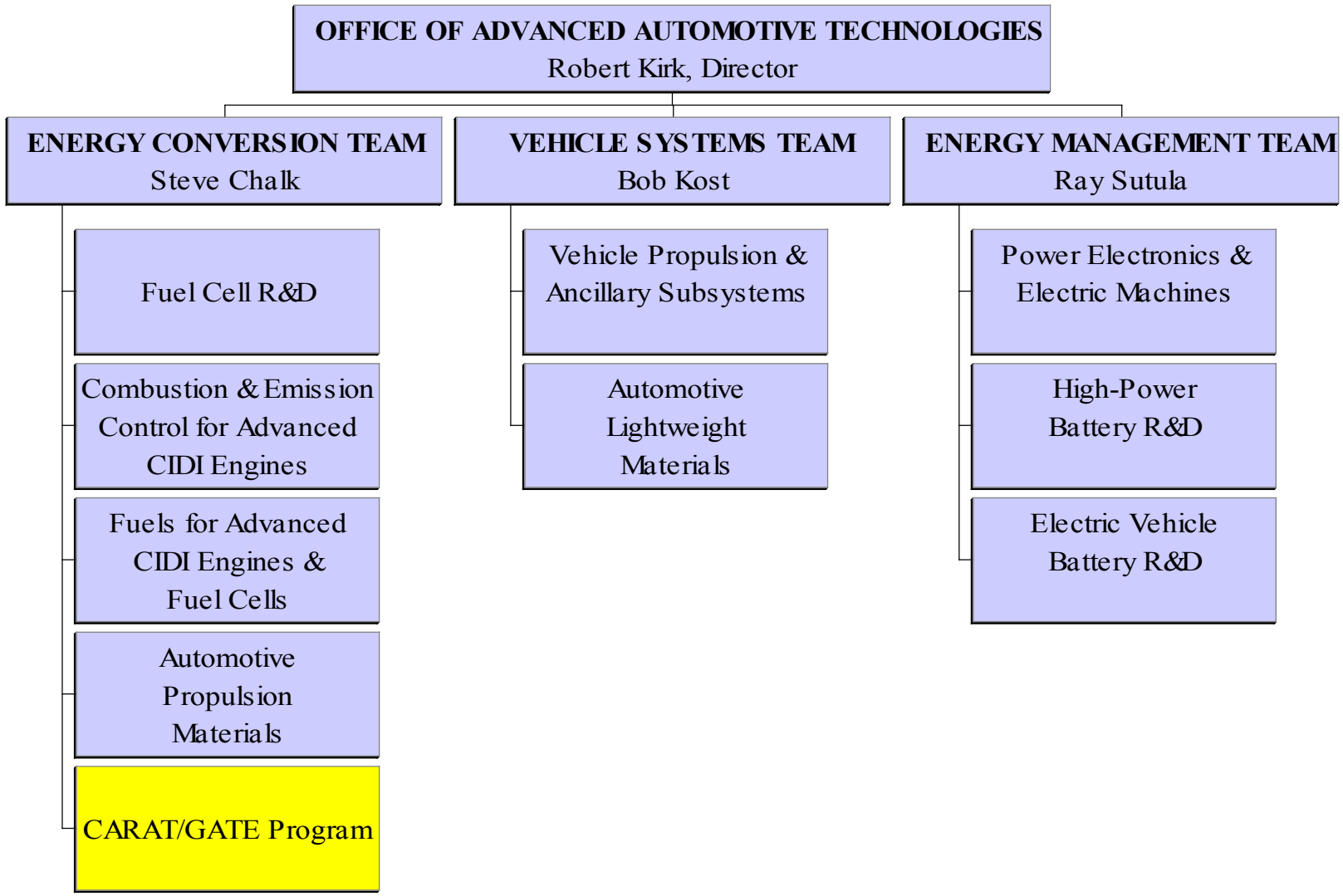
Cooperative Automotive Research for Advanced Technology

Donna Lee Ho

2002 Merit Review and Peer Evaluation
DOE Fuel Cells for Transportation National Laboratory R&D
Golden, Colorado
May 9-10, 2001

Technology Areas Covered by CARAT



CARAT Objectives

- **To offer small businesses & universities opportunity to support OAAT R&D programs**
- **To accelerate progress on energy-efficient technologies needed for advanced vehicles**
- **To enhance working relationships between small businesses/universities & automotive manufacturers/suppliers**

CARAT is *NOT* another SBIR/STTR program:

- ✓ **focused on exclusively on automotive technologies**
- ✓ **cost-shared cooperative agreements, not grants**

CARAT Phases

Phase 1
Technology Feasibility

- Bench model
- Performance data
- Identification of cost & manufacturing barriers

- DOE share ≤ $150K
- 20% cost share
- Up to 12 months

Review Go/NoGo

Phase 2
Prototype Development

- Eng'ing prototype
- Meet performance specifications
- Analysis of potential for low-cost, high-volume fabrication

- DOE share ≤ $750K
- 20% cost share min.
- Up to 24 months

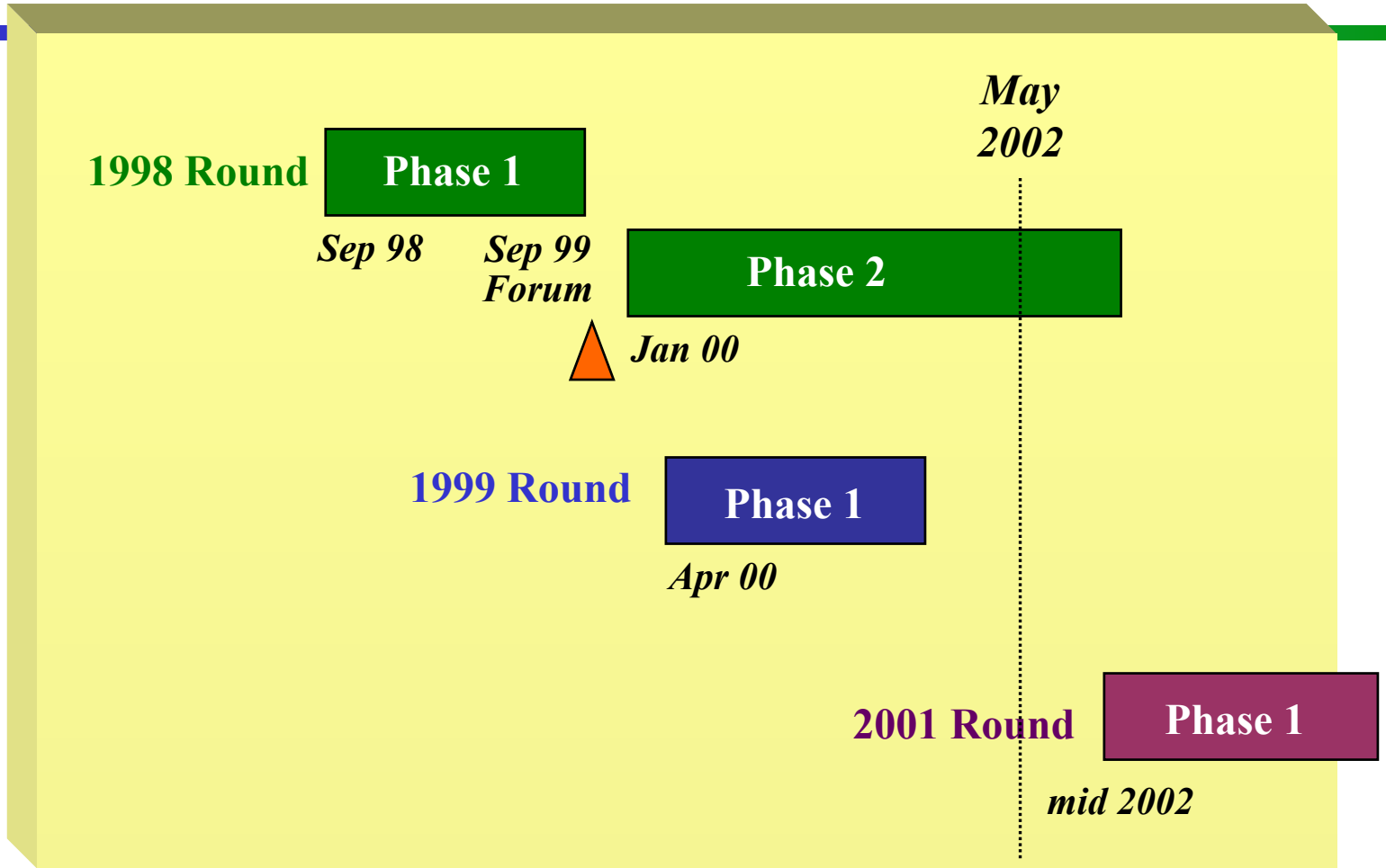
Review Go/NoGo
Select Industry Partner

Phase 3
Technology Validation

- Vehicle-scale, pre-production prototype
- Performance data
- Rigorous cost & manufacturing analysis

- DOE share ≤ $500K
- 50% cost share min.
- Up to 24 months

CARAT Schedule Overview



- 1998 Round: 26 Phase 1 awards, 7 were chosen for Phase 2
- 1999 Round: 5 Phase 1 Awards
- 2001 Round: Solicitation released 5/17/01, awards pending

2001 Solicitation Topics

(1) Alternative (Non-Lithium) Insertion Electrode Battery Technology

(2) Non-Carbon Anodes for Lithium-ion Batteries

(3) Fuel Cells for Auxiliary and Portable Power

(4) Homogeneous-Charge Compression-Ignition (HCCI) Engine Enabling Technology

(5) Cost-Effective, High-Efficiency Porous Media Heat Transfer

(6) Cost-Effective, High-Efficiency Materials for Thermoelectric Devices

(7) Cost-Effective, High-Efficiency Integrated Systems Approach to Auxiliary Electric Motors

- *Solicitation Released May 17, 2001, Applications Received July 16, 2001*
- *Expert evaluations completed Sept 2001*
- *Merit Review Committee made recommendations for awards by Dec 2001*
- *Committee Report written by January 25, 2002*
- *Currently awaiting approvals*

Phase 1 Projects (1999 Round)

(1) Development of Thermoplastic Matrix Composite Beams and Tubes for Automotive Applications
University of Michigan at Ann Arbor — *DOE/PM: Joe Carpenter*

(2) Development of Low-Cost Carbonaceous Materials for Anodes in Lithium-ion Batteries for Electric & Hybrid Electric Vehicles
Superior Graphite — *DOE/PM: Ken Heitner*

(3) Development and Processing of Novel Carbon Materials for Lithium-ion Systems
BST Systems — *DOE/PM: Tien Duong*

(4) Low Cost Chemical Composition and Mass Flow Sensor System for Compression Ignition Engines Using MEMs Based Sensor Technology
Makel Engineering — *DOE/PM: Ken Howden*

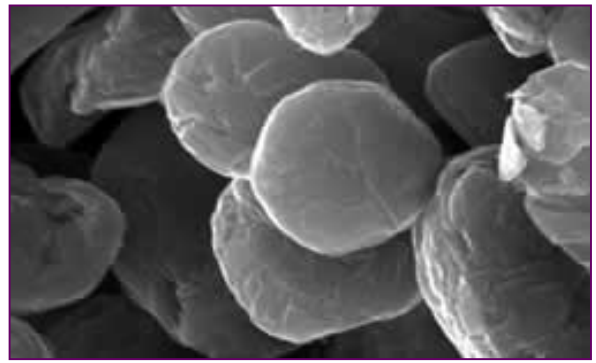
(5) Use of Micro-PCM Fluids as Enhanced Liquid Coolants in Automotive Electric and Hybrid Electric Vehicles
North Carolina State University — *DOE/PM: David Hamilton*

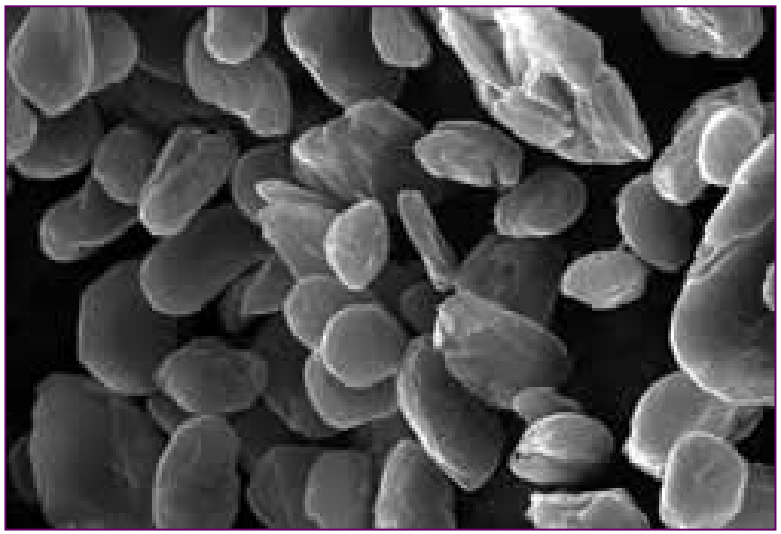
CARAT Highlight

Superior Graphite Company

Development of Low-Cost, Novel Carbonaceous Materials For Anodes in Lithium-Ion Rechargeable Batteries

Superior Graphite researchers successfully developed three commercially viable carbonaceous products for anodes in lithium batteries for electric and hybrid vehicles. Results of the extensive in-house testing of these materials have been cross-referenced with results from the Illinois Institute of Technology and were found to be in good agreement. Samples of these new materials have been tested further at Argonne National Lab. The preliminary performance has been acceptable and several prospective automotive battery manufacturers are currently testing samples.





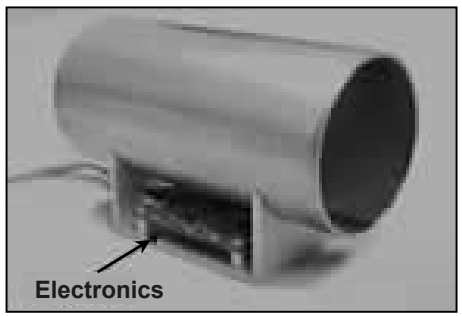
Precision-sized particles may now allow use of thin electrode assemblies having 50 mm-thick active material films, with less concern about possible short circuits caused by the particles. Another significant result is a new capability to manufacture spheroid shape particles (see photo). Particles of natural graphite with this shape were found to have significantly increased packing density compared to the flake structures, which may result in a significant increase in energy densities, as more graphite can now be fitted in a fixed volume of a battery.

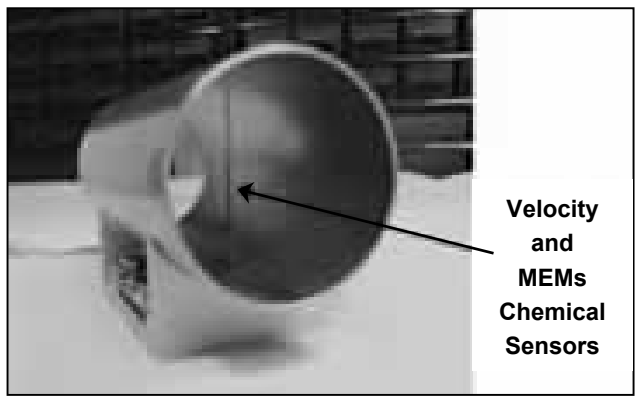
CARAT Highlight

Makel Engineering, Inc.

A Combined Mass Flow Rate & Chemical Composition Sensor for the Intake of CIDI Engines Using MEMS

Makel Engineering developed a combined mass flow rate and chemical composition sensor for the intake of compression ignition engines for fuel injection and emissions control. The sensors utilize Micro-Electro-Mechanical Systems (MEMS) technology that can be mass-produced at low cost. A prototype sensor was designed, fabricated, and tested (see photos below). The sensor uses solid-state, thin sensors for pressure, temperature, oxygen concentration, hydrocarbon concentration, and flow velocity. Bench testing has been performed using calibrated gas flows simulating steady and fluctuating flows in engine intakes. Sensor performance was validated at up to 2,200 rpm and with oxygen concentration variation from 10 to 21%. The sensor demonstrated the ability to accurately account for transient variations in mass flow. Further testing on a laboratory-mounted CIDI engine at the University of California, Berkeley demonstrated the sensor to produce readings in agreement with the test-stand-flow-measurement equipment.





Prototype, low-cost MEMS-based engine mass flow sensor

Phase 2 Projects (1998 Round)

(1) Reduction of Thermal Load in Passenger Compartments
Energy Conversion Devices — *DOE/PM: Roland Gravel*

(2) Low-Cost, Compact, High-Efficiency Traction Motor for EV's
Virginia Power Technologies — *DOE/PM: Jim Merritt*

(3) Advanced Water-Gas Shift Catalysts for Fuel Cell Systems ★
University of Michigan — *DOE/PM: Pat Davis*

(4) Advanced Water-Gas Shift Catalysts for Fuel Cell Systems ★
NexTech Materials — *DOE/PM: Pat Davis*

(5) Advanced Membranes and MEA's for Fuel Cell Systems
Pennsylvania State University — *DOE/PM: JoAnn Milliken*

(6) Low-Cost CO & Hydrogen Sensors
Illinois Institute of Technology — *DOE/PM: Pat Davis* ★

(7) Computer Models for Simulation of Fuel Cell Performance ★
University of Miami — *DOE/PM: Donna Ho*

Contact Information

CARAT Website:

www.ipd.anl.gov/carat/carat.html

Donna Lee Ho
202-586-8000 (phone)
202-586-9811 (fax)
Donna.Ho@ee.doe.gov